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Evaporation Memorandum No.35.

DUPLICATE ALSO

A provisional and approximate assessment of the total land-use of Great Britain for hydrometeorological modelling

by

B G Wales-Smith (Appendix by M J Prior)

1. Introduction

An assessment of the land-use of Great Britain by percentages of land in 40 x 40km squares (Fig.1) and for the categories given in Table 1 was required for the modelling system described by Wales-Smith (1975). Inquiries made between 1970 and 1973 failed to reveal the existence of any comprehensive land-use assessment of the type required. Detailed data on the useage sub-division of agricultural land are, of course, archived by the Ministry of Agriculture, Fisheries and Food and by the Department of Agriculture and Fisheries for Scotland; comprehensive information on forestation is held by the Forestry Commission. The last Land Utilisation Survey was published in 1944 (Ordnance Survey 1944) and inquiries revealed that work to update the 1944 map was in progress under the direction of Miss A. M. Coleman. This memorandum describes the collection and processing of data to provide a provisional assessment of land-use capable of being improved, as and when possible, by the substitution of higher-quality data for the initial approximations.

Table 1. Land-use categories for hydrometeorological modelling.

Totally impermeable surfaces
Fresh water
Non-arable riparian land*
Rocky slopes, etc.
Coniferous woodlands
Heather, gorse, etc.
Permanent grass
Broadleaved woodlands
Orchards
Rough grazing
Cereals and hops
Vegetables, soft fruit and flowers
Temporary grass

* defined as non-arable land where the roots of (mostly shallow-rooted) vegetation are rarely if ever short of water.

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2. Sources of data for the provisional assessment

(a) Returns for a considerable number of squares and part-squares were received from some of the former Conservancies and River Authorities of England and Wales. Some of these returns were prepared by or under the supervision of Miss Coleman. The Department of Agriculture and Fisheries for Scotland gave valuable guidance on the land-use of that country.

(b) When it became clear that there would be long and unavoidable delays in completing the survey as described in (a) a provisional and very approximate survey was carried out by the writer and the results of this were used to fill the gaps in the returns mentioned in (a).

3. Approximate (Meteorological Office) assessment of the land-use of Great Britain

The assessment was prepared as follows:

(a) percentages of the total land in each, old-style county devoted to permanent grass, temporary grass, rough grazing, orchards, cereals and hops and vegetables, soft fruit and flowers were calculated from Agricultural Statistics (MAFF 1969), (DAFS 1972),

(b) percentages of fresh water areas in each, old-style county were calculated from the Census of Woodlands (Forestry Commission 1968).

(c) percentages of the land area in each square within each, old-style county were estimated, carefully,

(d) the results of (a) and (b) were converted to percentages of land in grid-squares using weighting obtained from (c),

(e) the maps in the Forestry Commission's 52nd Annual Report (Forestry Commission 1968) were overlaid by the 40 x 40km grid to enable the locations of major woodlands to be identified. Tabulated data on public and private coniferous and broadleaved woodlands were used in estimating the sizes of individual areas of woodland. Average figures of the percentages of woodlands consisting of "high forest" were used as a guide to the likely residual areas of scrubland; these latter were included in the class "heather and gorse",

(f) percentages of land in grid-squares covered by heather and gorse and by rocky slopes, etc, were estimated from a variety of maps,

(g) percentages of land in grid-squares covered by man-made, impermeable surfaces (buildings, roads, etc) were obtained by applying the 40 x 40km grid to a population density map (Bartholomew 1963), obtaining average values of people per km^2 and converting the latter to estimates of percentages of impermeable surface.

The relationship used was derived from Escritt (1950) as follows. The relationships obtained by Escritt and by De Courcy Meade were plotted for the range 100 to 10,000 people per km^2 and compared with the results of the writer's assumptions (a) that one detached house plus outbuildings, paths, pavement and a share of domestic roads and non-residential buildings covers $134m^2$ and the house accommodates 4.7 people and (b) that non-residential roads cover 0.2% of total area in sparsely populated areas and 1.0% in urban areas. Taking mean values between figures obtained from these assumptions and De Courcy Meade's results gave values slightly larger (in terms of hard-surface area per person) than obtained by Escritt and thus, perhaps, take some account of increased urbanisation since 1950. The rough relationships are given in Table 2.

Table 2. Approximate relationship between average population density (people per km^2) and percentage of land area hard-surfaced (h.s)

%h-s	people per km^2	%h-s	people per km^2	%h-s	people per km^2
1	150-220	9	581-650	17	1381-1550
2	221-270	10	651-730	18	1551-1730
3	271-320	11	731-810	19	1731-1930
4	321-360	12	811-900	20	1931-2150
5	361-420	13	901-1000	21	2151-2400
6	421-470	14	1001-1120	22	2401-2700
7	471-520	15	1121-1250	23	2701-3000
8	521-580	16	1251-1380	24	3001-3350
				25	3351-3800

(h) the generally small percentages of non-arable riparian land were assessed on the basis of guide lines provided by Smith (1975).

4. Combination of results to provide a provisional land-use data-set

(a) The survey results received from other agencies (see 2a) were combined with the approximate results obtained as described in 3 to provide a first set of land-use data (by percentages) for each grid-square.

(b) The 40 x 40km grid was applied to the 1944 Land Utilisation map. Percentages of these squares devoted to:

Major urban areas
Fresh water
Heathland, moorland and rough pasture
Woodlands
Meadowland and permanent grass
Arable land
Orchards and nursery gardens

were estimated, by eye taking each 10 x 10km square as 6% of the containing 40 x 40 km square. These results were compared with single or combined totals of land-uses in the more detailed Table 1 set of categories and adjusted to take account of the assumptions that the 1944 survey gives lower limits for woodlands, arable land and orchard percentages, upper limits for heathlands etc and meadowland etc percentages, good data of fresh water percentages and comparative (square to square) values of hard-surfaced percentages.

5. General remarks and cautions

The whole series of processes is shown, schematically in Fig.2. The assessment took several years (of discontinous effort) to complete and may be criticised on the grounds of its reliance on data obtained over more than one year. It is probably realistic to regard the final assessment as being an approximation to the truth in, say, 1970.

It will be appreciated that there are considerable approximations in this assessment and also variations in its quality from area to area. The work was undertaken following painstaking but unsuccessful enquiries aimed at finding a ready-made assessment. The writer apologises to any individual or organisation from whom (or which) better assessments than those used could have been obtained if requested. Anyone using the assessment is strongly advised to read the account of its preparation in order to form a judgment of its likely value for any given purpose.

6. Storage of the land-use data bank in computer and other media

Format. The data set is described by M J Prior in the Appendix.

Storage. The data set is stored on 9-track magnetic tape and can be transferred to any other tape.

Seasonal effects. As explained in the Appendix - monthly percentages are stored to allow for the growth and harvesting of crops and for the life cycle of deciduous foliage.

Albedo. Monthly estimates of the average albedo of the ground in a square can be obtained from the data set by making assumptions about the albedo of vegetation at various stages and of other land categories.

Mapped data and computer output. The data set is available as "all squares/one category" maps (see Figs 3-16) as computer print-out as specified in the Appendix and on magnetic tape.

Acknowledgments

The writer acknowledges his dependence on the publications listed and the help of J H Alexander (of DAFS) who assembled the Scottish contribution, former Conservancy and River Authority hydrologists, Miss A M Coleman, J Cochrane, M J Prior who designed the data set, L P Smith and of P Wiltshire who did much of the tedious arithmetic.

References

1. Wales-Smith, B.G. (1975) The estimation of irrigation needs. Engineering Hydrology Today. ICE London 1975, 45-54.

2. Ordnance Survey (1944) Land Utilisation of Great Britain.

3. MAFF (1969) Agricultural Statistics for England and Wales 1967-8.

4. DAFS (1972) Agricultural Statistics 1971 Scotland.

5. Forestry Commission (1968) Census of Woodlands 1965-7.

6. Forestry Commission (1968) Fifty-second Annual Report.

7. Bartholomew (1963) Advanced Atlas of Modern Geography 7th Ed, Oliver & Boyd, Edinburgh, p.36.

8. Escritt, L.B. (1950) Surface Water Sewerage

9. Smith, L.P. (1975) Personal communication.

Appendix

LAND USE OF GREAT BRITAIN

by M.J. Prior

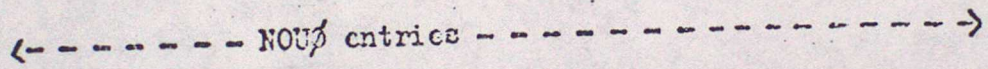
Subsequently, A data set was formed to store estimates of the percentages of each grid square devoted to various land uses, neglecting the sea and percentages less than 1%. Seasonal variations in those land use percentages were included, where applicable. Each data block holds the details of 10 grid squares and the header record contains an index for locating the relevant block of any given grid square. The data set was designed for use with the GRACCESS subroutine and all information is in half-word integer items.

Header Record (Block 1)

Preliminary array

Item	Meaning	Name
1	Number of preliminary items	NOPØ
2	Number of entries in index (= 19Ø)	NOUØ
3	Number of items in each index entry	NIRØ
4	Number of fixed items (= NOUØ)	NOFØ
5	Spare (- 32768)	-
6	Spare (- 32768)	-
7	Sequence number of this block	NRØ
8	Number of blocks available in data set	NVLB

Main array



	Item	Meaning
↑ NIRØ items ↓	1	Grid square number
	2	(Block sequence no.)x1Ø+Ø,1,2.....9, according to which record in the block is the relevant one.

*two, in the Irish Sea, contain no data.

Blocks 2 to 20

Preliminary array

Item	Meaning	Name
1	Number of items in preliminary array	NOP
2	Number of unit records in main array (= 1Ø)	NOU
3	Number of items in each unit record	NIR
4	Number of fixed items (= NIR)	NOF
5	Spare (- 32768)	-
6	Spare (- 32768)	-
7	Sequence number of block	NR

Main array

← - - - - - - - - NOU records - →

	Item	Meaning
↑	1	Number of 40 km x 40 km grid square
	2	NGR easting of centre of grid square (100 m units)
	3	NGR northing of centre of grid square (100 m units)
	4	Latitude of centre of grid square (tenths of degrees)
	5	Mean altitude of grid square (m above MSL)
	6	Spare (- 32768)
	7	Spare (- 32768)
	8	Percentage of Urban land
	9	" " Water
	1Ø	" " Riparian land
	11	" " Rock, Steep bare slopes
NIR items	12	" " Coniferous woods
	13	" " Heather, Gorse etc
	14	" " Permanent Grass
	15	" " Rough Grazing
	16	" " Temporary Grass
	17-28	12 monthly percentages of Deciduous Woods in leaf
	29-4Ø	" " " " Orchards in leaf
	41-52	" " " " Deciduous Woods and Orchards not in leaf
	53-64	" " " " Cereals and Hops
	65-76	" " " " Root, Vegetable and Fruit crops
	77-88	" " " " Fallow Ground (Bare Soil) *
↓	89-1ØØ	Spare (- 32768)

Note: Any missing values are stored as - 32768

The land use data set is at present held on label 1 of tape no. ØØØ129 and JCL of the following form is required in order to use it:

```
//SYSUT1 DD DSN=M$8.JLANDUSE,UNIT=TAPE9,VOL=(,RETAIN,SER=ØØØ129),
//       LABEL=(1,SL),DISP=(OLD,KEEP),DCB=(RECFM=F,LRECL=2Ø14,BLKSIZE=2Ø14)
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* subsequently removed from classification and data-set.

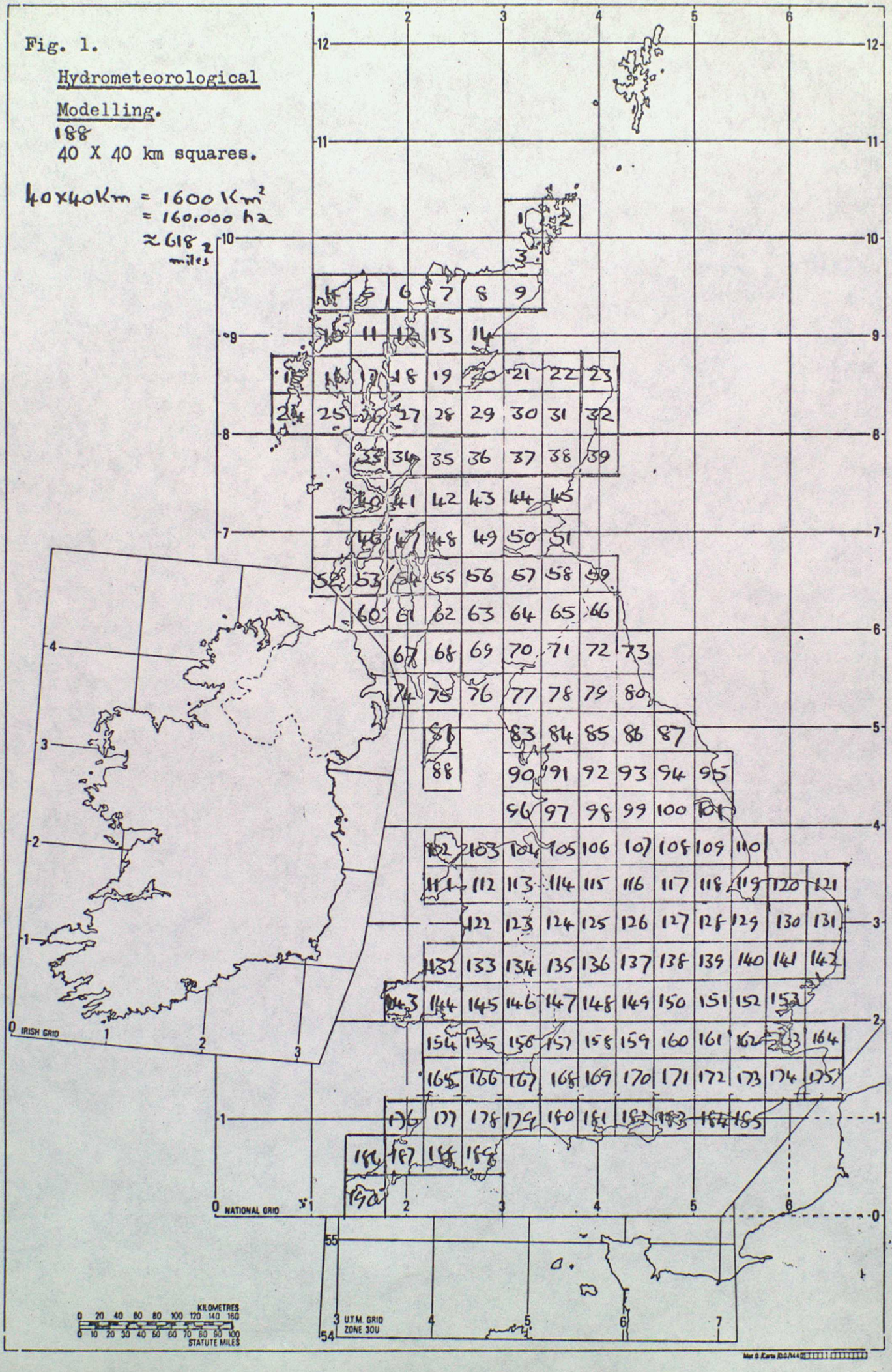


Fig. 1.
Hydrometeorological
Modelling.
188
40 X 40 km squares.
40x40Km = 1600 Km²
= 160,000 ha
≈ 618 miles²
IRISH GRID
NATIONAL GRID
U.T.M. GRID
ZONE 30U
KILOMETRES
STATUTE MILES

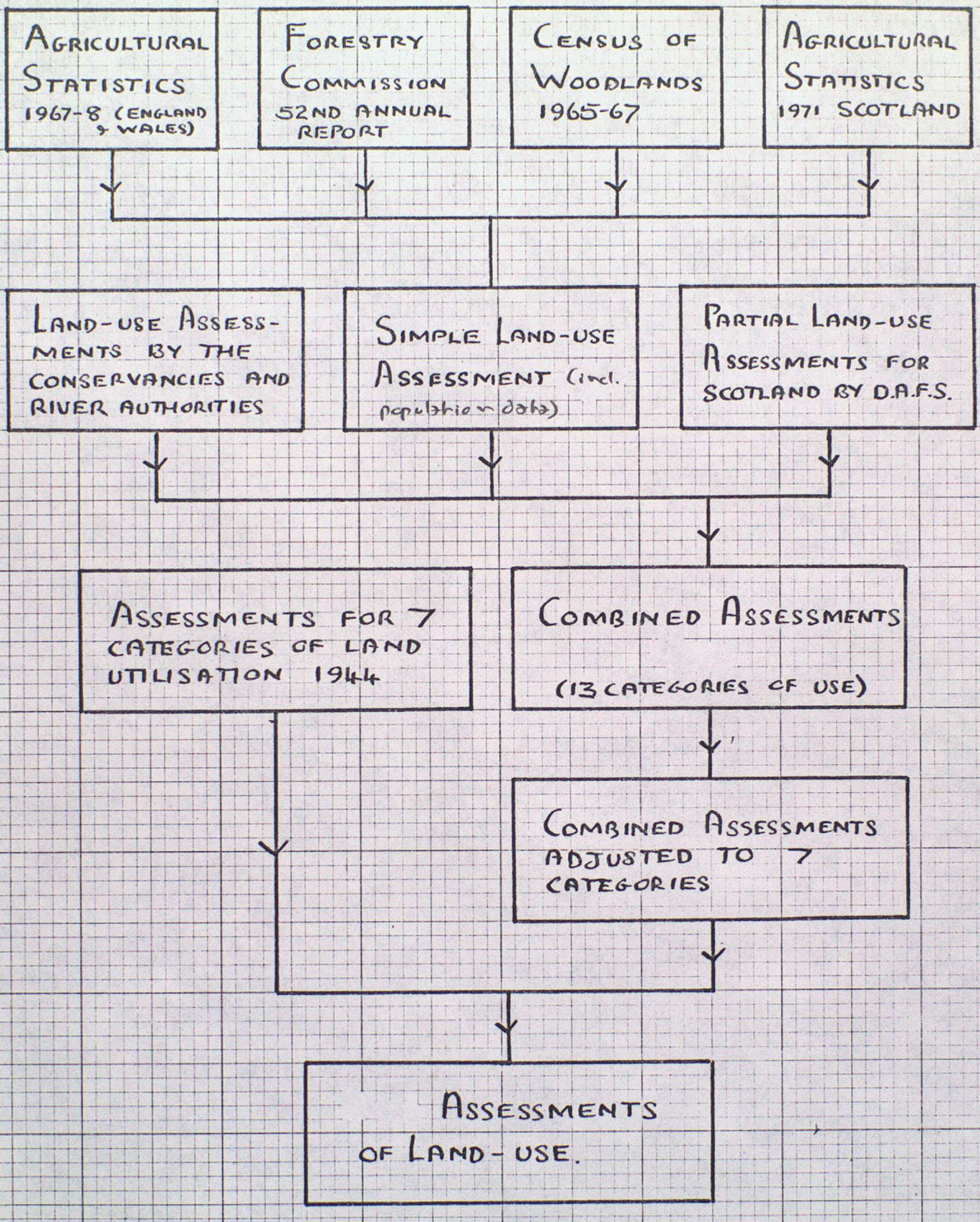
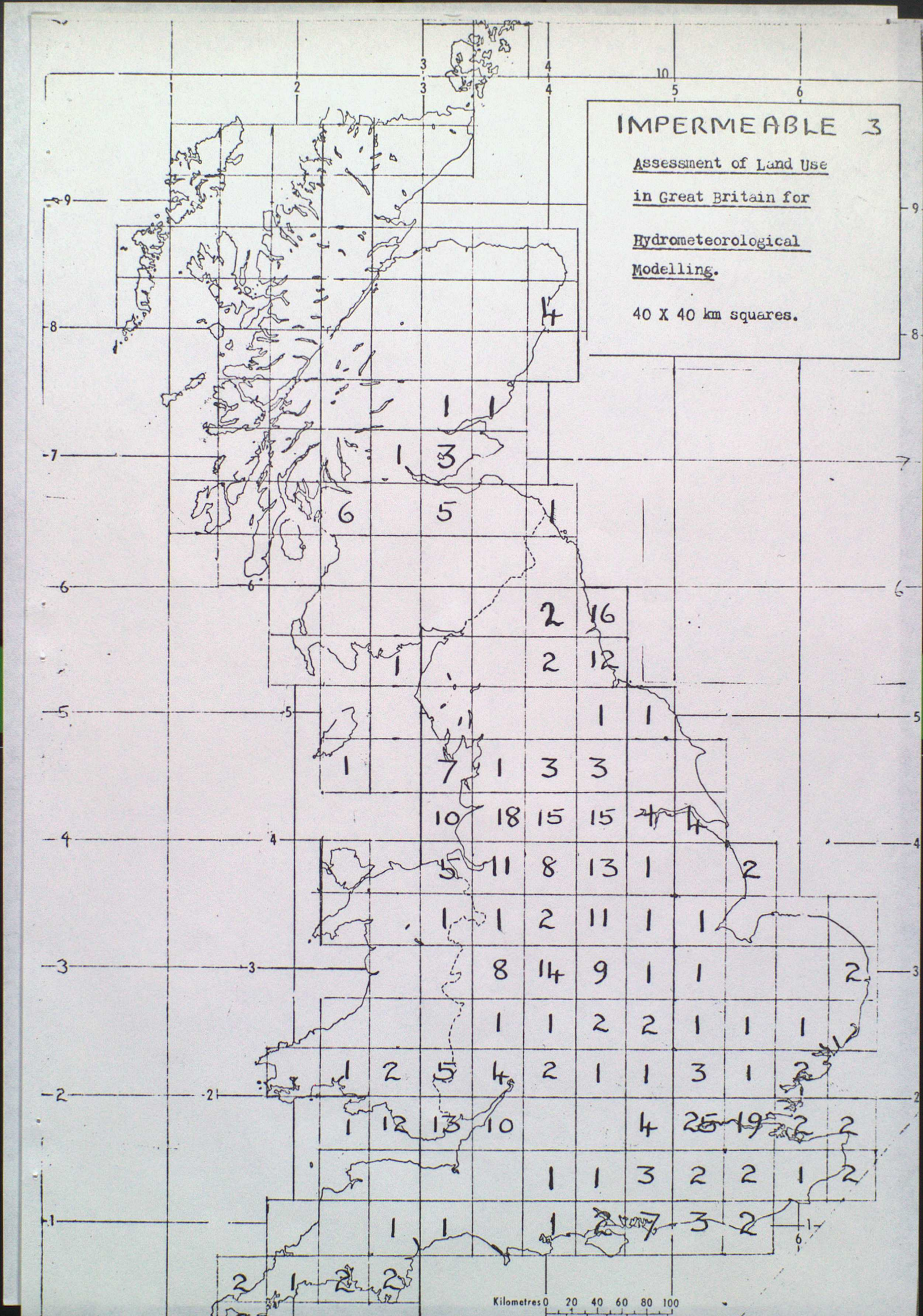
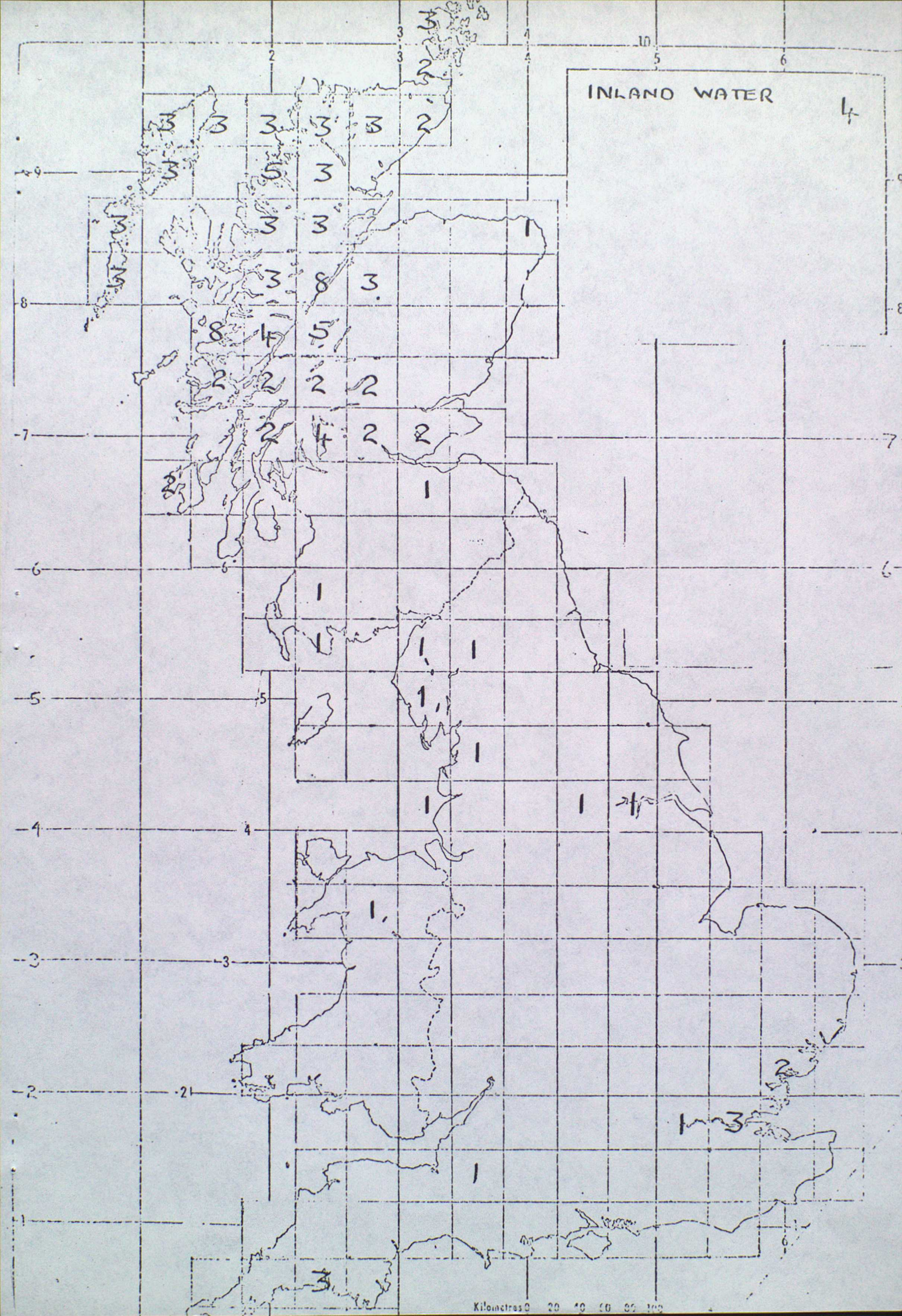
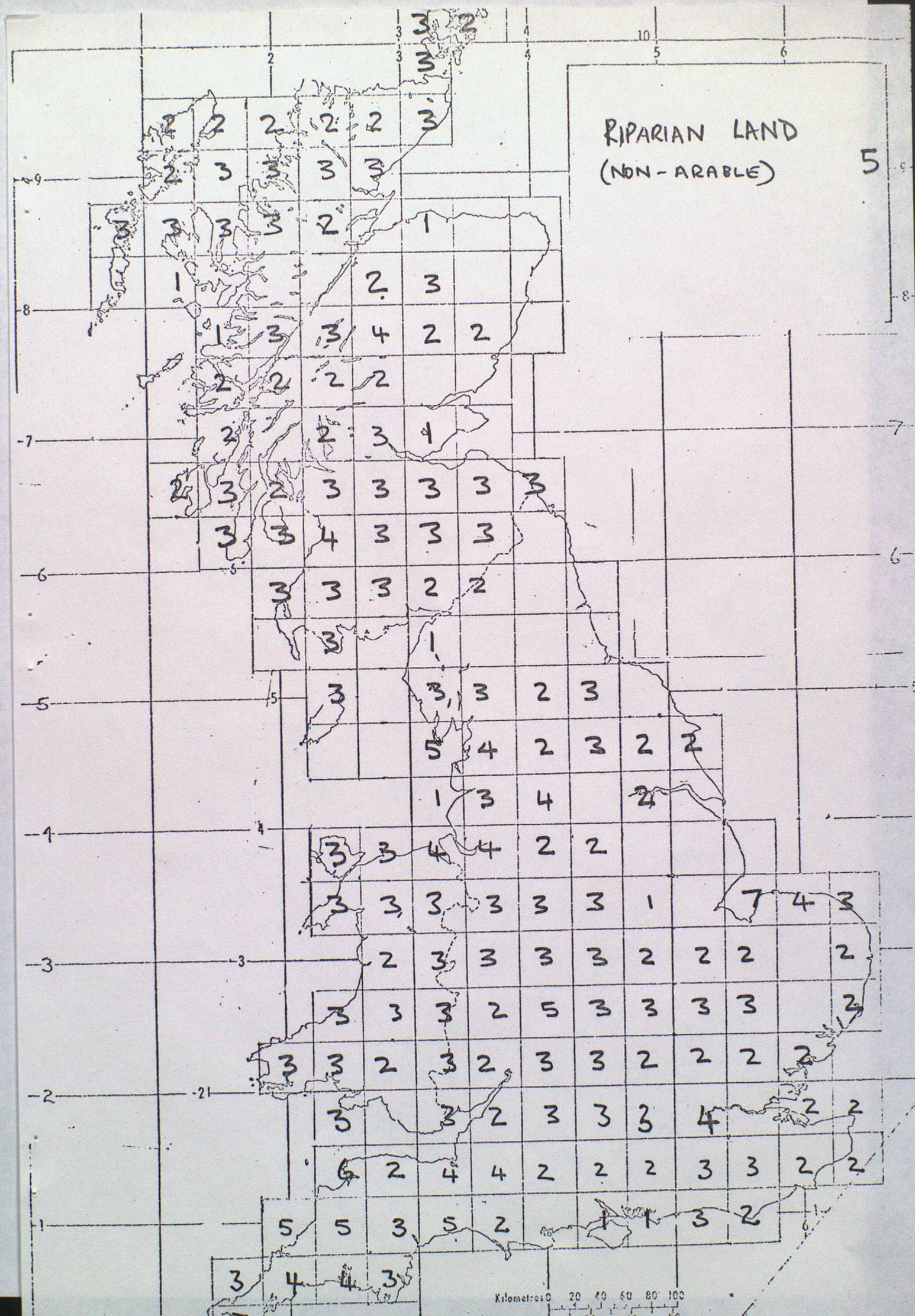
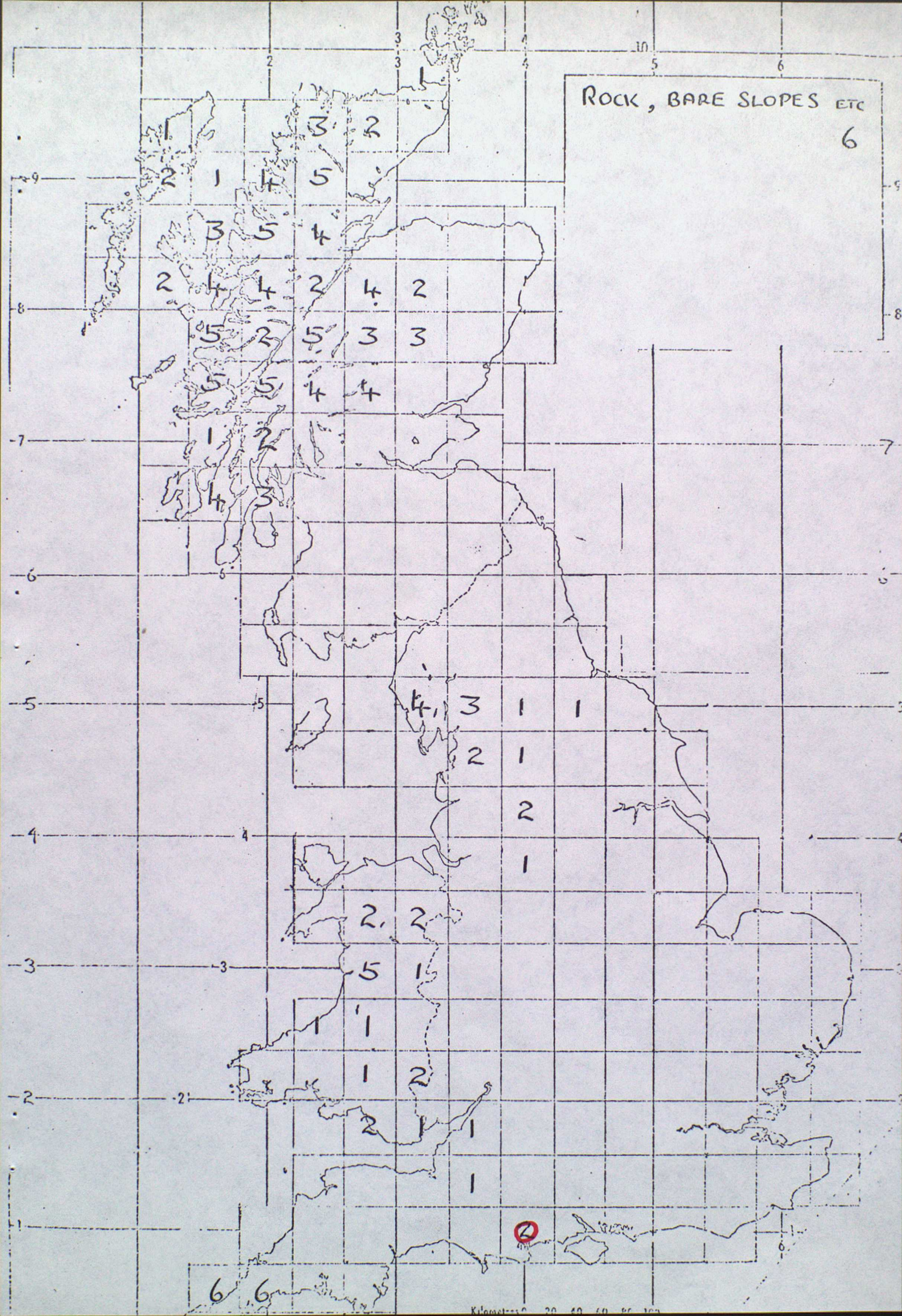

AGRICULTURAL STATISTICS 1967-8 (ENGLAND & WALES)
FORESTRY COMMISSION 52ND ANNUAL REPORT
CENSUS OF WOODLANDS 1965-67
AGRICULTURAL STATISTICS 1971 SCOTLAND
LAND-USE ASSESSMENTS BY THE CONSERVANCIES AND RIVER AUTHORITIES
SIMPLE LAND-USE ASSESSMENT (incl. population data)
PARTIAL LAND-USE ASSESSMENTS FOR SCOTLAND BY D.A.F.S.
ASSESSMENTS FOR 7 CATEGORIES OF LAND UTILISATION 1944
COMBINED ASSESSMENTS (13 CATEGORIES OF USE)
COMBINED ASSESSMENTS ADJUSTED TO 7 CATEGORIES
ASSESSMENTS OF LAND-USE.

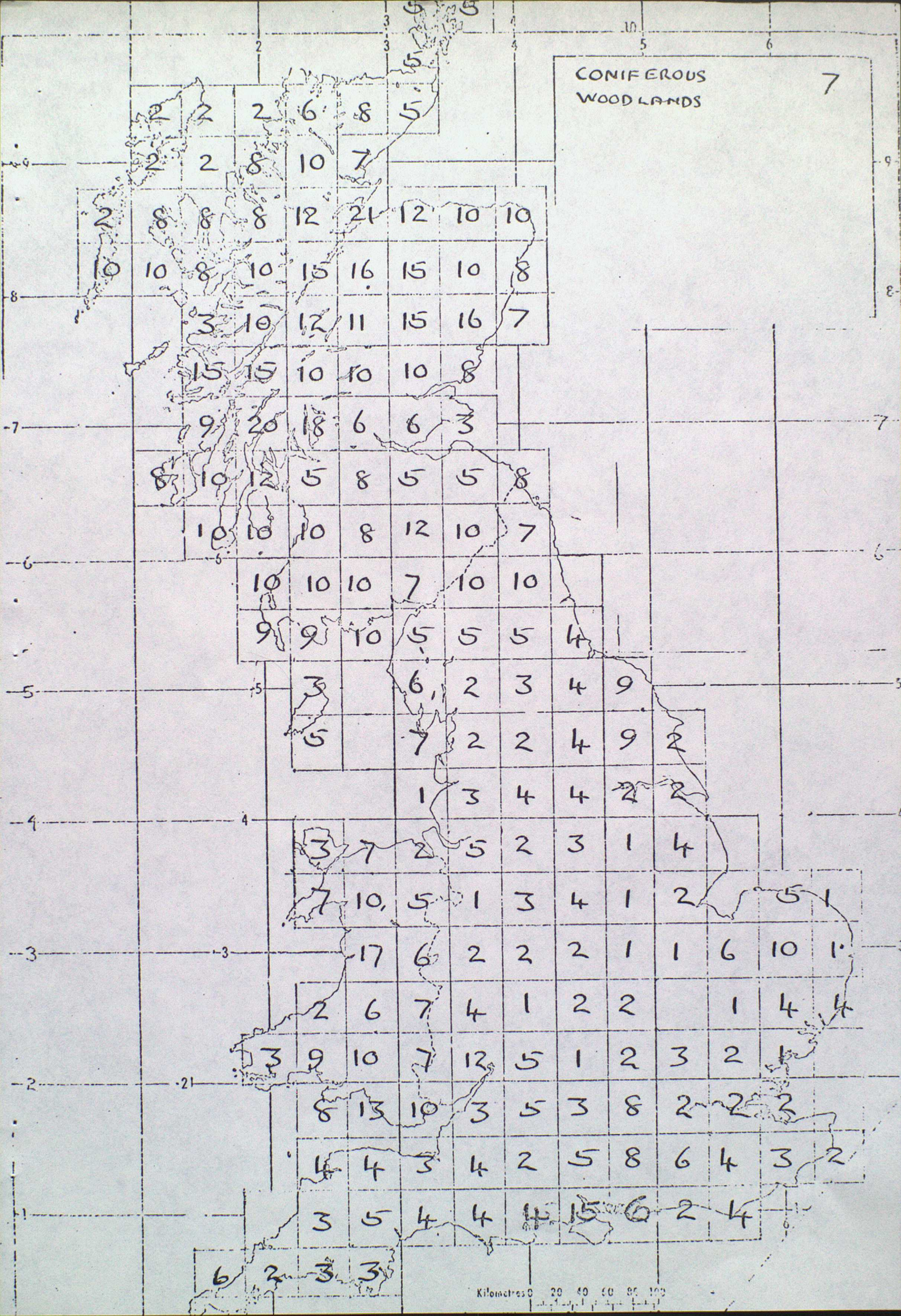
Fig.2. Combination of land-use data to produce provisional assessments, by percentages of 13 categories of land-use, for the land areas within 188 40 X 40 km squares covering Great Britain.

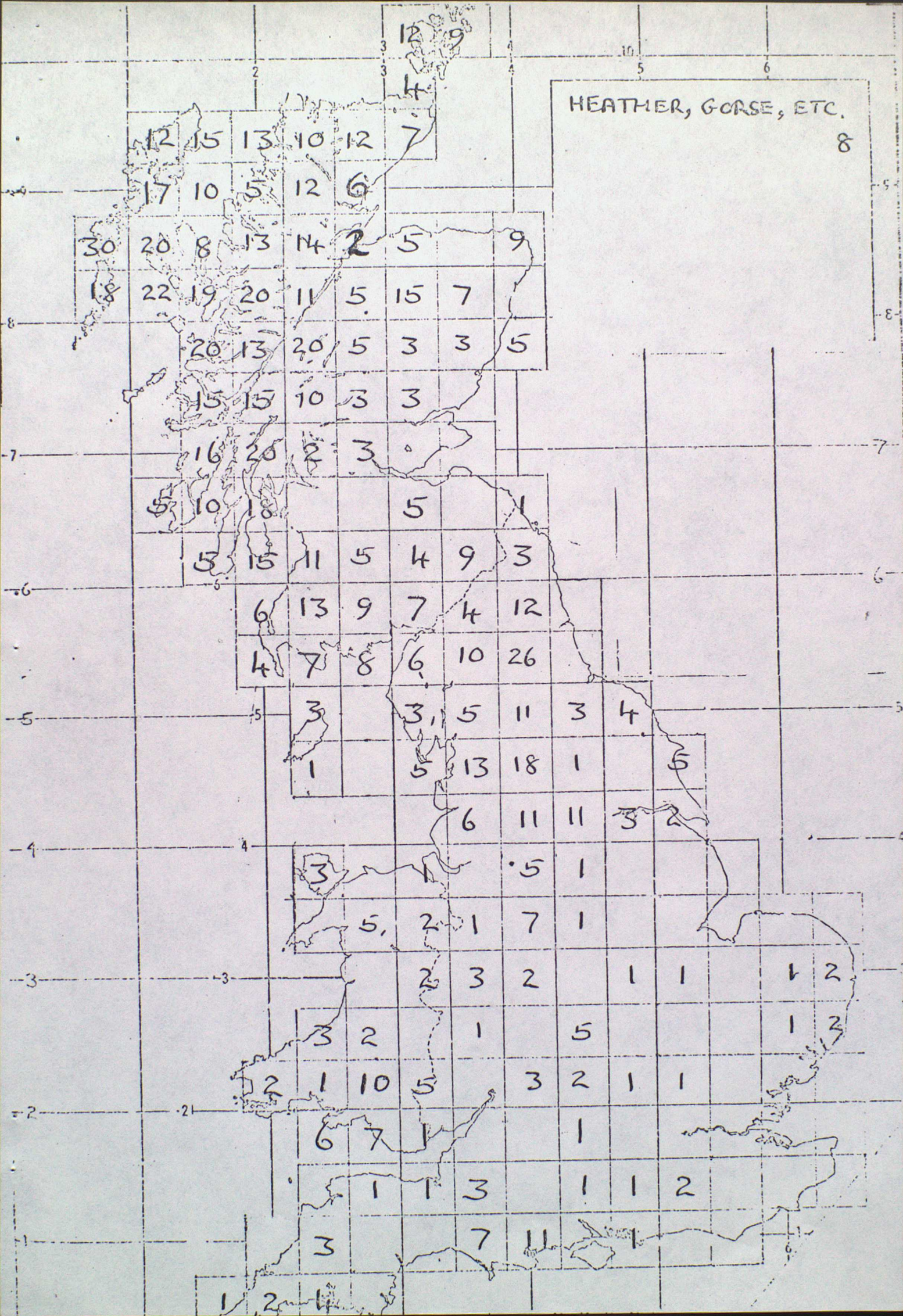

IMPERMEABLE 3
Assessment of Land Use
in Great Britain for
Hydrometeorological
Modelling.
40 X 40 km squares.
Kilometres 0 20 40 60 80 100

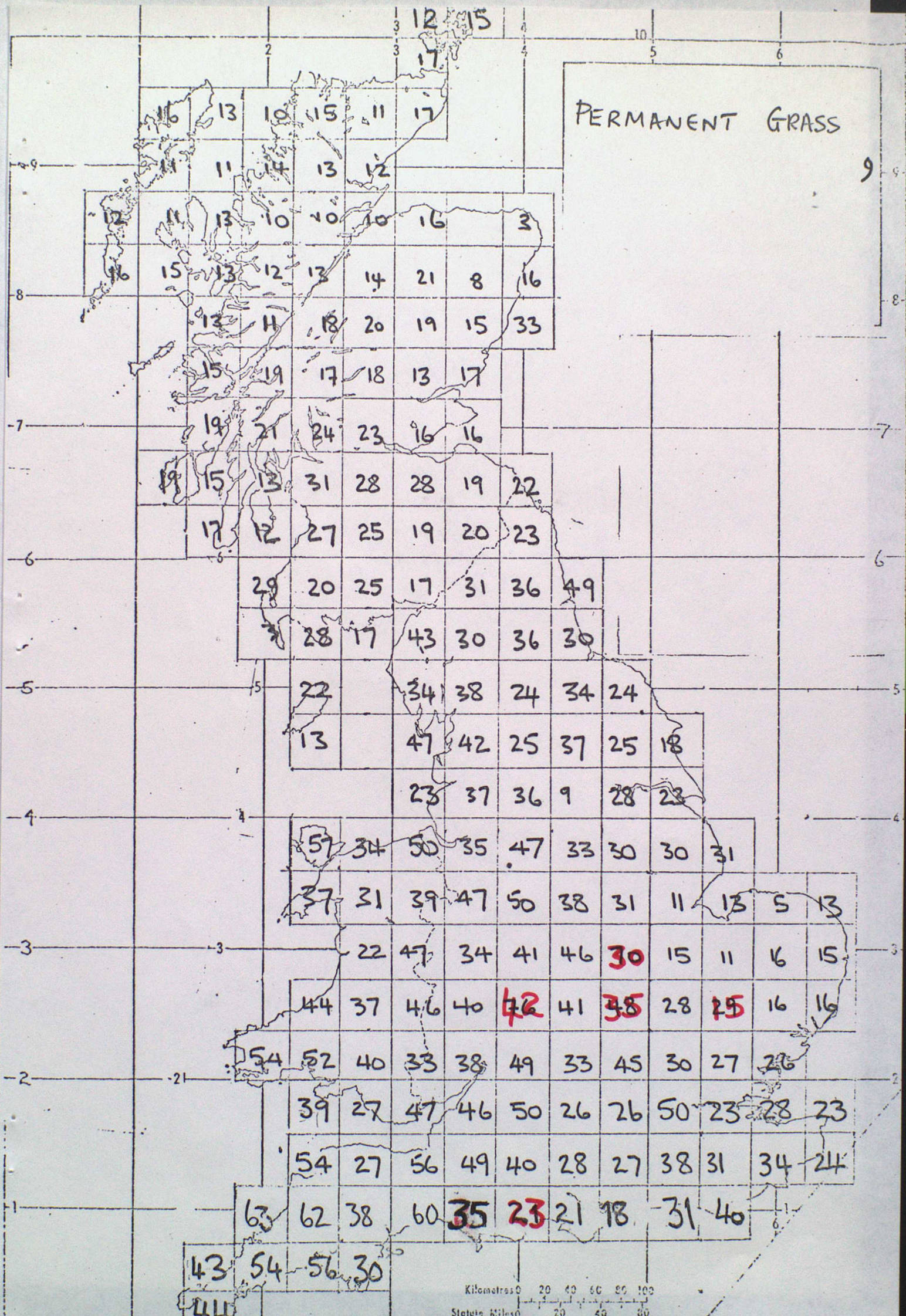

INLAND WATER
4
Kilometres 0 20 40 60 80 100

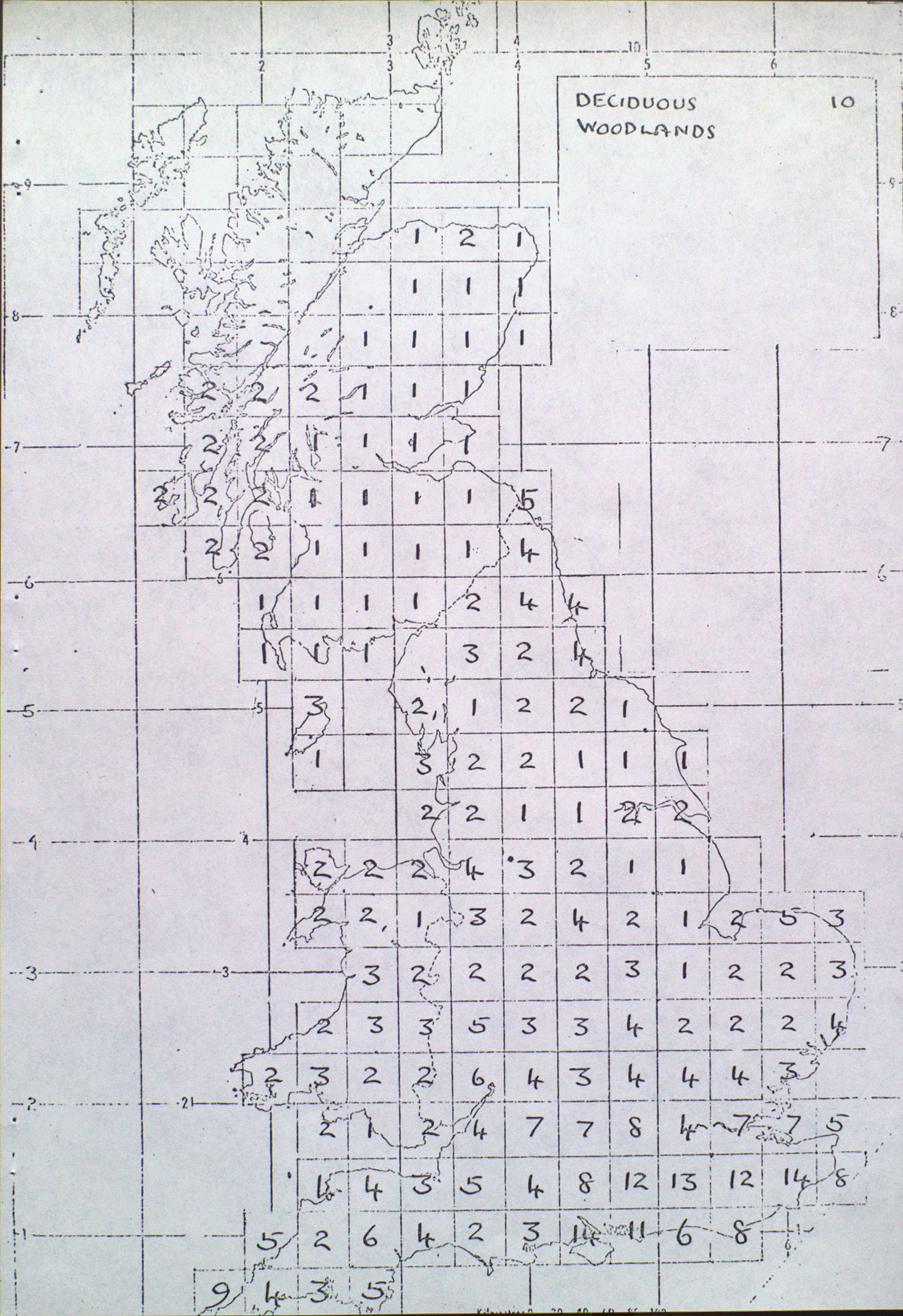

RIPARIAN LAND
(NON-ARABLE)
5
Kilometres 0 20 40 60 80 100

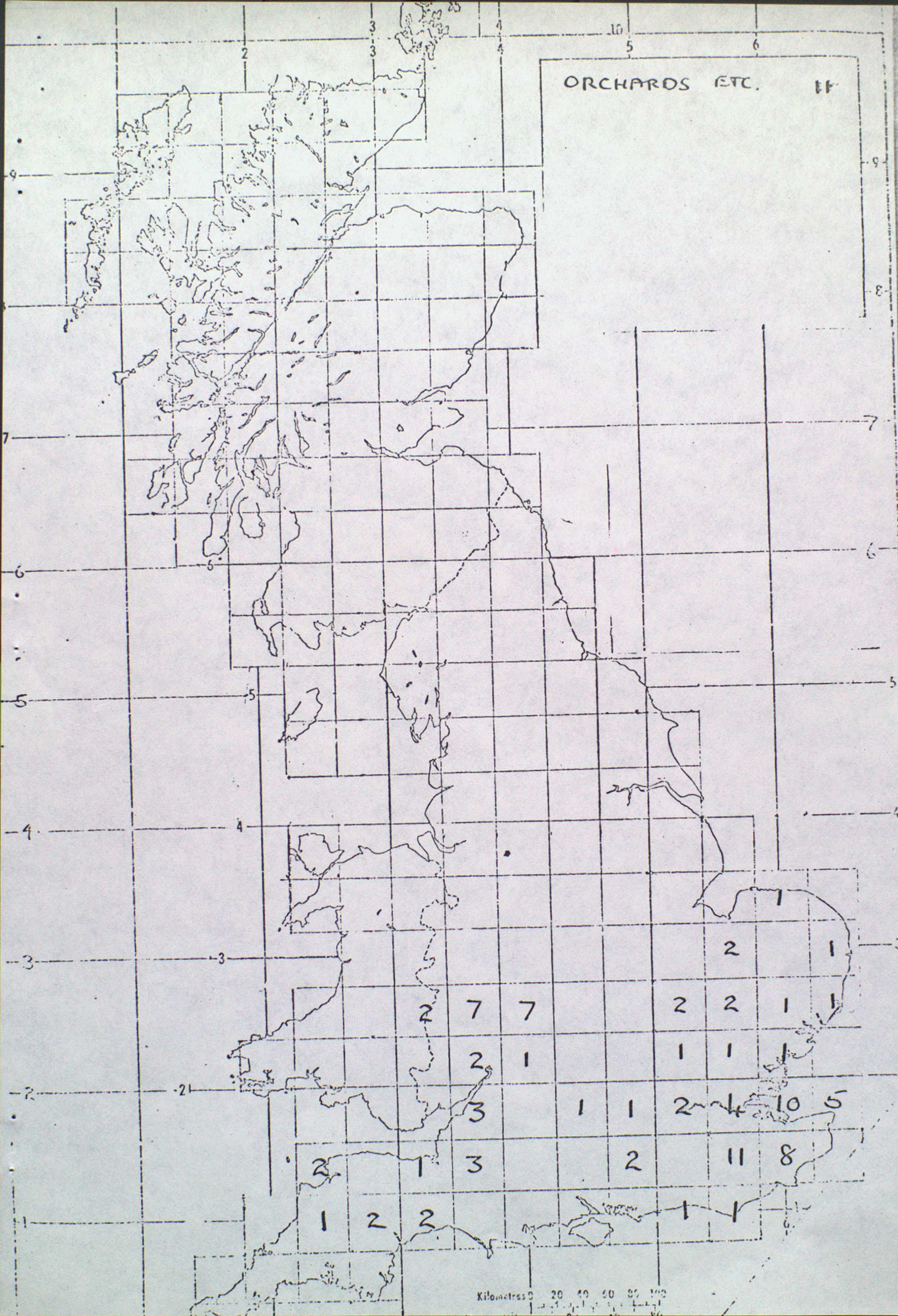

ROCK, BARE SLOPES ETC
6

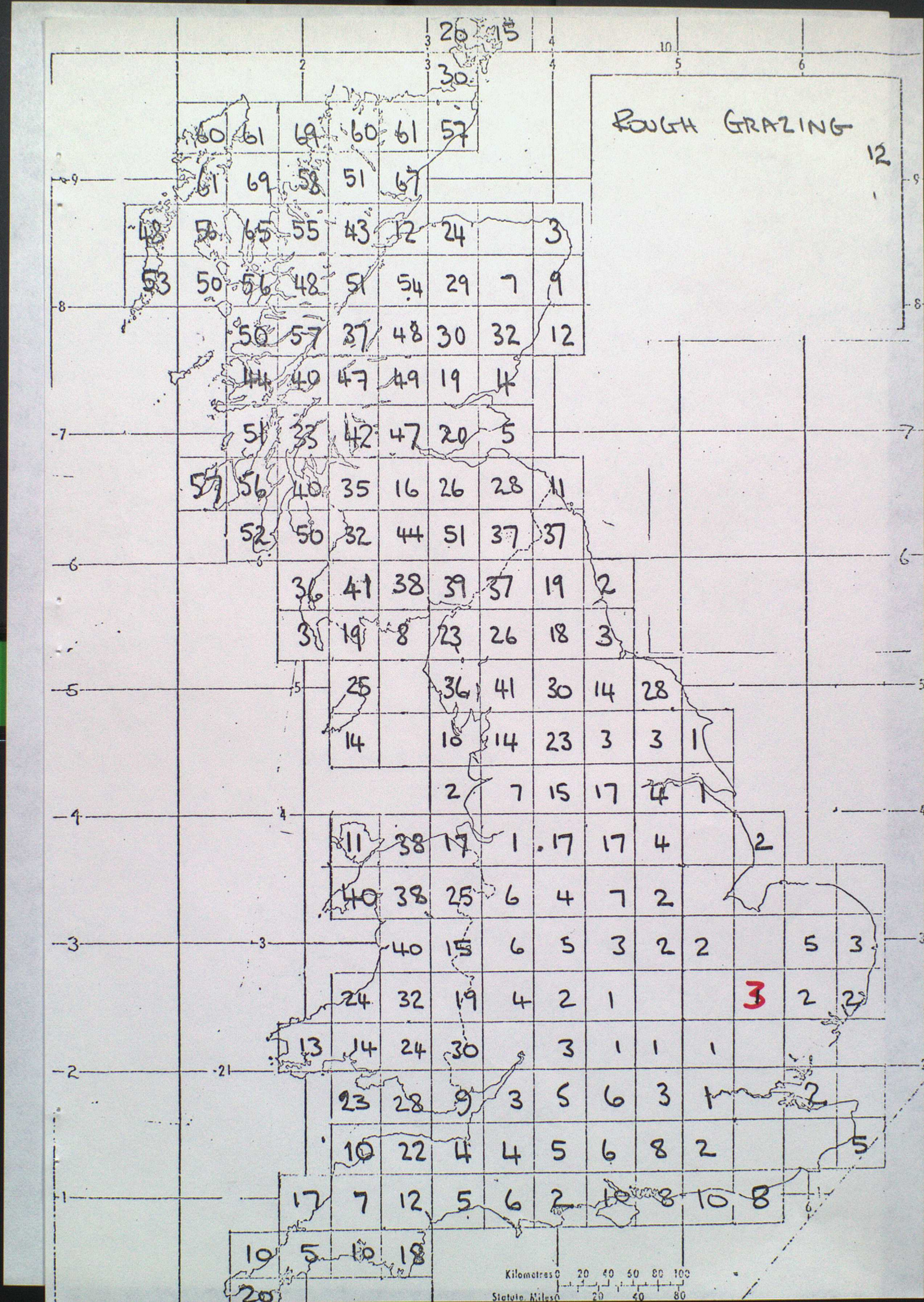

CONIFEROUS
WOODLANDS
7
Kilometres 0 20 40 60 80 100

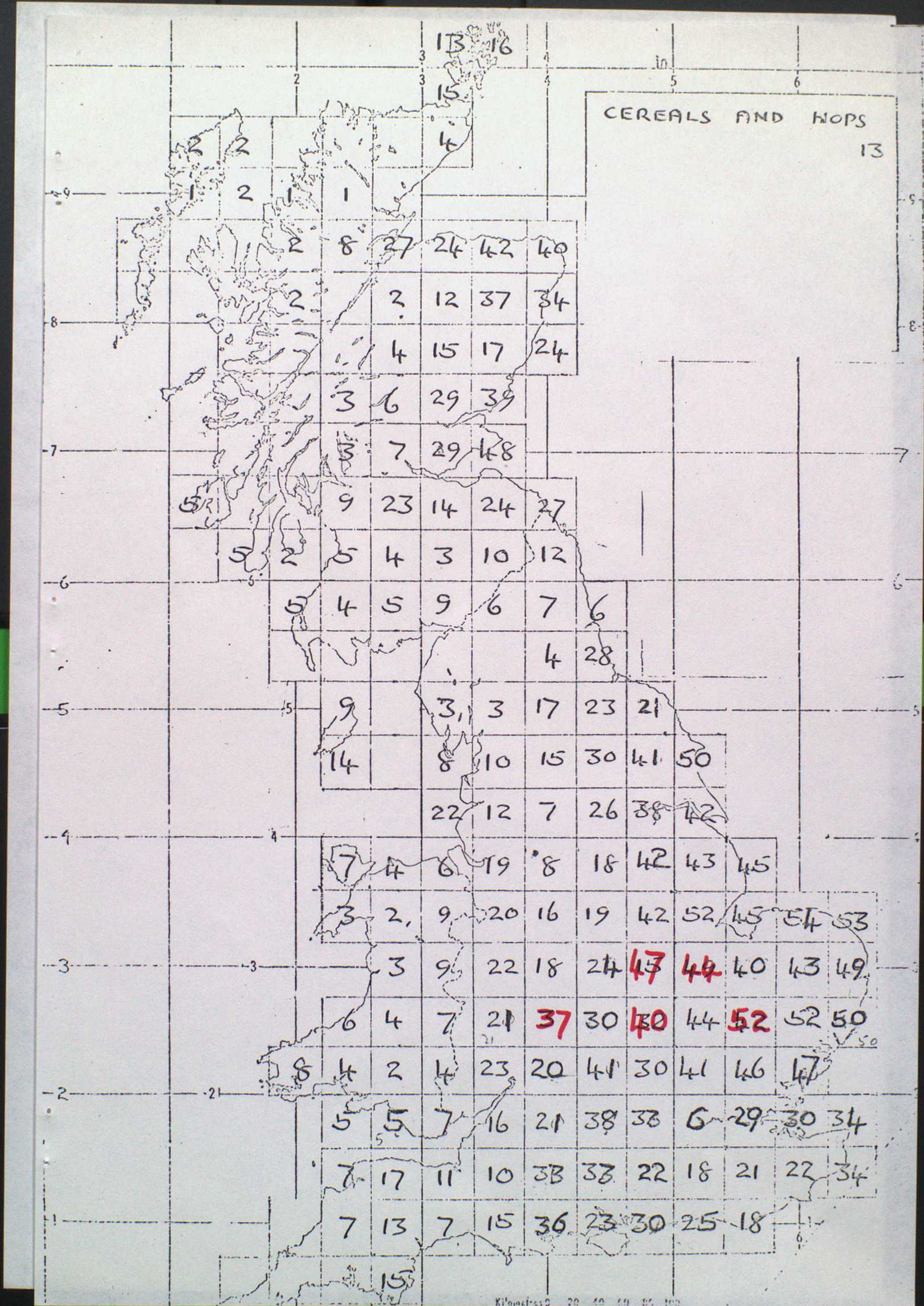

HEATHER, GORSE, ETC.
8

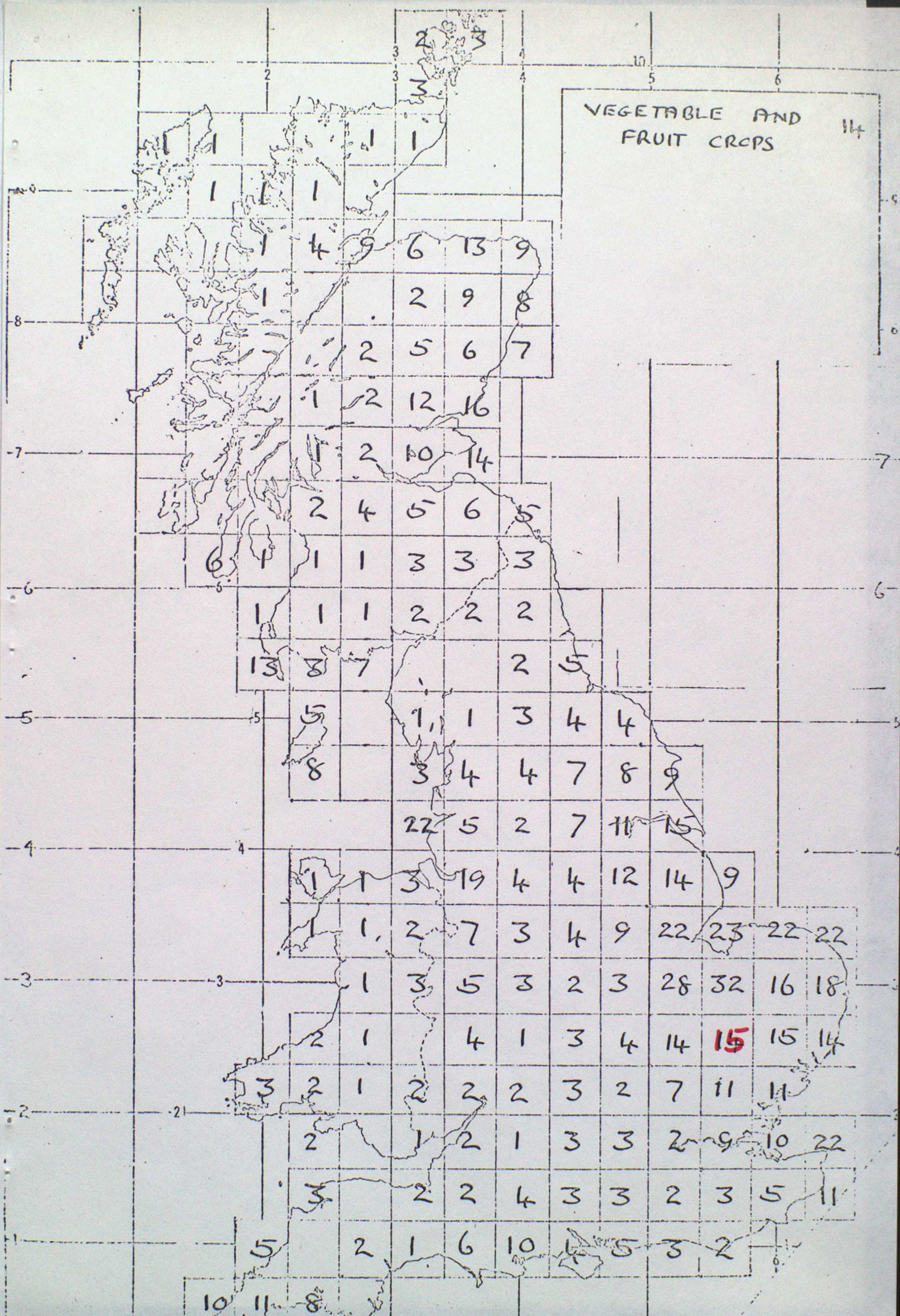

PERMANENT GRASS
9
Kilometres 0 20 40 60 80 100
Statute Miles 0 20 40 60

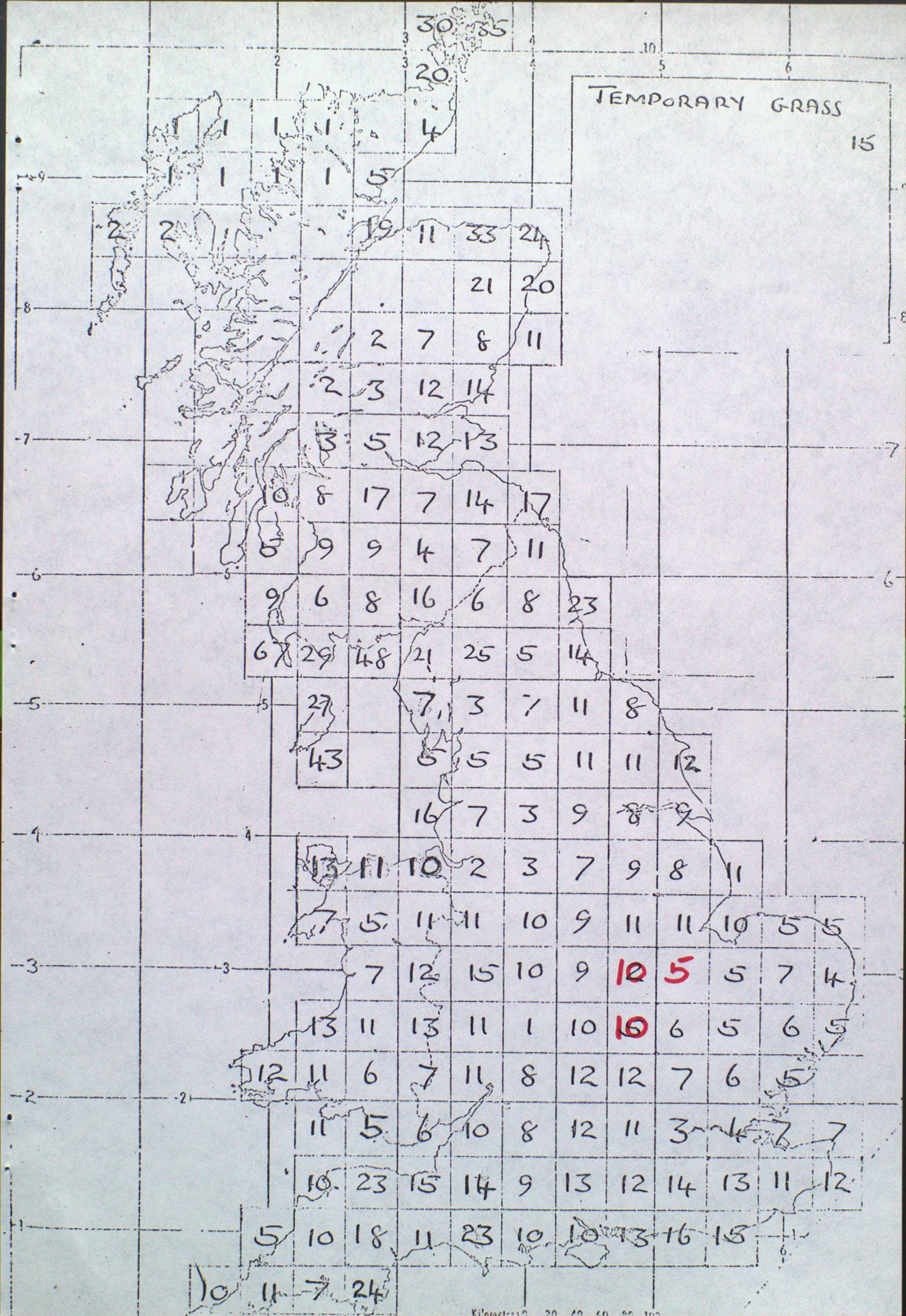

DECIDUOUS
WOODLANDS
10


ORCHARDS ETC.
11
1
2 1
2 7 7 2 2 1 1
2 1 1 1 1
3 1 1 2 4 10 5
2 1 3 2 11 8
1 2 2 1 1
Kilometres 0 20 40 60 80 100


ROUGH GRAZING
12
Kilometres 0 20 40 60 80 100
Statute Miles 0 20 40 60 80


CEREALS AND HOPS
13


VEGETABLE AND FRUIT CROPS
14


TEMPORARY GRASS
15